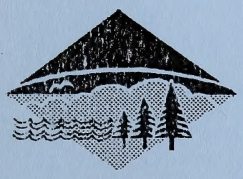
# SUMMARY OF AIR QUALITY MONITORING IN ALBERTA 1993



Alberta

ENVIRONMENTAL PROTECTION

# SUMMARY OF AIR QUALITY MONITORING IN ALBERTA 1993

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This report is one in a series of air quality annual reports produced by Alberta Environmental Protection for 1993. The following air quality annual reports are available for 1993:

**Summary of Air Quality Monitoring in Alberta: 1993.**
**Air Quality Monitoring Report for Alberta: 1993.**
**Air Quality Monitoring Data Summary for Alberta: 1993.**

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# OVERVIEW

Alberta Environmental Protection is responsible for monitoring air quality and reporting air quality information to Albertans. In 1993, the provincial monitoring network consisted of 11 continuous stations, 8 intermittent stations, over 250 static stations and 12 precipitation quality stations. In addition, portable and mobile air quality monitoring was undertaken in response to public concerns and municipal requests. A total of 17 air pollutants were monitored by the air quality network in 1993.

The *I*ndex of the *QU*ality of the *A*ir (IQUA) is used to relate Good, Fair, Poor and Very Poor air quality conditions in terms that are easily understood by the general public. Outdoor concentrations of carbon monoxide, the coefficient of haze (dust and smoke), nitrogen dioxide, ozone and sulphur dioxide are used to determine this index.

Based on the IQUA, an upward trend in Good air quality is evident in downtown Calgary. A trend in annual average IQUA values is not apparent at any other monitoring stations. In 1993, Good air quality occurred more frequently than the long-term average at Calgary, Fort Saskatchewan and Fort McMurray stations. The Edmonton central and east monitoring stations recorded slightly less Good IQUA ratings than the long-term average.

Good air quality occurred at least 86% of the time at all Alberta Environmental Protection monitoring stations in 1993. Good IQUA ratings were recorded more than 96% of the time at the Calgary residential (northwest Calgary), Calgary downtown, Fort Saskatchewan and Fort McMurray stations. The lowest frequency of Good IQUA ratings was reported at the Edmonton northwest, Edmonton east and Calgary industrial (southeast Calgary) monitoring stations. Fair air quality conditions were observed most frequently at these three stations. With the exception of the Edmonton northwest station, Poor air quality occurred less than 1% of the time at Alberta monitoring stations. Very Poor IQUA ratings were recorded for one hour at the Edmonton northwest and east stations in 1993. Fair, Poor and Very Poor air quality conditions are generally due to the combination of light winds, stable weather conditions, and automobile emissions during rush hour traffic periods.

In 1993, concentrations of carbon monoxide and nitrogen dioxide were lower than the long-term average at all monitoring stations. Coefficient of haze (dust and smoke) values were higher than the long-term average at Edmonton, Fort Saskatchewan and Fort McMurray stations and lower than the long-term average at all Calgary stations. A downward trend in carbon monoxide concentrations is indicated at most stations. A significant downward trend in nitrogen dioxide is evident at downtown Edmonton and Calgary monitoring stations. The 1 and 8-hour guidelines for carbon monoxide were exceeded occasionally at Edmonton and Calgary stations located near main traffic arteries. The annual average guideline for nitrogen dioxide was exceeded at the Calgary downtown monitoring station. The guideline for the coefficient of haze was not exceeded at any monitoring stations in 1993. Major sources of carbon monoxide, nitrogen dioxide, and dust and smoke are vehicle exhaust emissions.

Annual average ozone concentrations in 1993 were equal to or lower than the long-term average at all Calgary stations, Edmonton northwest and east stations, and the Fort Saskatchewan station. However, a trend towards higher ozone concentrations is evident at the Calgary downtown, Edmonton central and Fort McMurray monitoring stations. This trend may be due to lower nitric oxide concentrations in downtown Edmonton and Calgary. Ozone that is naturally present in the atmosphere is destroyed by nitric oxide emissions from motor vehicles. Therefore, lower nitric oxide concentrations in the downtown cores of Edmonton and Calgary will lead to higher ozone levels at these locations. Ozone concentrations higher than the long-term average were recorded at the Edmonton central and Fort McMurray stations.

The one-hour guideline for ozone was exceeded four times at Alberta Environmental Protection monitoring stations in 1993. As in past years, the 24-hour guideline was exceeded frequently at all monitoring stations. Exceedances of the 24-hour guideline were caused by natural ozone producing processes such as: (1) the reaction of sunlight with organic compounds and oxides of nitrogen; and (2) transport of ozone to ground level from the upper atmosphere.

Total hydrocarbon concentrations in 1993 were lower than the long-term average at the Edmonton northwest, Edmonton east, Calgary downtown and Fort MacKay monitoring stations. Annual average hydrocarbon values were higher than the long-term average at Edmonton downtown, Calgary residential, Calgary industrial, Fort Saskatchewan and Fort McMurray stations. The highest annual average total hydrocarbon concentration was recorded at the Edmonton central monitoring station. Long-term trends in total hydrocarbons show increasing concentrations at the Calgary residential and Fort Saskatchewan stations and decreasing values at the Edmonton northwest station. The major source of hydrocarbons is vehicle exhaust emissions. Industrial facilities are also a substantial source of some types of hydrocarbons (especially east Edmonton).

Sulphur compounds such as sulphur dioxide and hydrogen sulphide are emitted primarily by industrial facilities. The 1-hour guideline for sulphur dioxide was exceeded one time at each of the Edmonton east and Fort MacKay stations. Guidelines for hydrogen sulphide were exceeded at the Edmonton east, Fort Saskatchewan and Calgary industrial monitoring stations. Exceedances of sulphur dioxide guidelines were due to emissions from local industries. Hydrogen sulphide guidelines were exceeded because of fugitive emissions from local industries or near-by sewage lagoons.

A downward trend in suspended particulate loadings is apparent at most Edmonton and Calgary monitoring stations. This trend is likely related to more paved roads and more efficient automobile engines. With the exception of the Edmonton east and Calgary industrial stations, particulate loadings at Alberta stations in 1993 were lower than the long-term average. The 24-hour guideline for suspended particulates was exceeded occasionally at all monitoring stations. The annual average guideline was exceeded at the Edmonton east and Calgary industrial stations.

Loadings of benzo (a) pyrene recorded in 1993 were significantly higher than those recorded in the past few years (1990 to 1992) at most monitoring stations. However, annual average benzo (a) pyrene loadings in 1993 were lower than the long-term average at Edmonton central, Calgary downtown and Calgary residential stations. Sulphate and nitrate loadings were also higher in 1993 than those recorded in the mid and late 1980s at all stations.

Carbon dioxide is monitored in downtown Calgary and at the Springbank Airport (20 km west-northwest of downtown Calgary). Annual average carbon dioxide concentrations at these two locations were 394 and 366 ppm (parts per million), respectively. These values are higher than the average recorded at Crossfield (from 1985 to 1987), situated 40 km north of Calgary. Higher values in downtown Calgary are primarily due to vehicle exhaust emissions.

As in previous years, the most acidic precipitation was recorded at the Fort McMurray precipitation quality station (pH of 4.7). Annual average precipitation pH at the remaining stations ranged from 5.0 to 5.3. The pH of uncontaminated precipitation is close to 5.6. An increase in precipitation acidity is evident at several stations based on data collected from 1978 to 1990. This trend is likely due to better data collection and sampling techniques (i.e. less dust contained in the samples). Effective acidity values were within proposed guidelines for adequate protection of sensitive soils at all precipitation stations in 1993.

Detailed air quality information and data are available in the reports entitled:

- "Air Quality Monitoring Report for Alberta: 1993"; and
- "Air Quality Monitoring Data Summary for Alberta: 1993".

These reports are available on request from Alberta Environmental Protection.

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## ABBREVIATIONS

IQUA - index of the quality of the air

$O_3$ - ozone

CO - carbon monoxide

$CO_2$ - carbon dioxide

COH - coefficient of haze

$NO_2$ - nitrogen dioxide

$SO_2$ - sulphur dioxide

$H_2S$ - hydrogen sulphide

THC - total hydrocarbons

TSP - total suspended particulates

BaP - Benzo (a) Pyrene

Pb - lead

VOC - volatile organic compound

## UNITS OF MEASUREMENT

ppm - parts per million by volume

ppb - parts per billion by volume

ug/$m^3$ - micrograms per cubic meter

ug/1000 $m^3$ - micrograms per 1000 cubic meters

mg/day/100 sq cm - milligrams of $SO_3$ per day per 100 square centimeters

mg/100 sq cm/30 days - milligrams per 100 square centimeters per 30 days

ug/100 sq cm/ 30 days - micrograms of water soluble fluorides per 100 square centimeters per 30 days

# SUMMARY OF AIR QUALITY MONITORING IN ALBERTA: 1993

## INTRODUCTION

In the early 1960s, the province began air quality monitoring at one station located in downtown Edmonton. By the mid 1970s, two more stations were added in Edmonton and by the end of the 1970s three stations were established in Calgary. In addition, air quality stations were installed at Fort McMurray, Fort MacKay and Fort Saskatchewan by the early 1980s. In the early 1990s, continuous air quality stations were added at Springbank (20 km west-northwest of Calgary) and Royal Park (10 km northwest of Vegreville) to monitor air quality representative of the rural environment. Today, a comprehensive network of 11 continuous stations, 7 intermittent stations, over 250 static stations and 12 acid precipitation stations make up the Alberta Environmental Protection air quality monitoring program. The objectives of the air quality monitoring program are to:

- *provide data for the assessment of existing air quality relative to guidelines and objectives;*
- *inform the public on the status of air quality;*
- *monitor air quality representative of urban environments;*
- *report long-term trends in air quality; and*
- *undertake monitoring in special problem areas.*

Air quality is an issue that is difficult to assess unless it is put into terms of a single, easily comprehensible indicator. The *I*ndex of the *QU*ality of the *A*ir (IQUA), developed by a federal-provincial committee in 1978, has been adopted by Alberta as well as other Canadian provinces.

## INDEX OF THE QUALITY OF THE AIR (IQUA)

The IQUA relates concentrations of five major pollutants to a common scale which may be easily interpreted by the public. This scale associates Good, Fair, Poor and Very Poor air quality categories with provincial guidelines and federal air quality objectives. Outdoor concentrations of carbon monoxide, the coefficient of haze (dust and smoke), nitrogen dioxide, ozone and sulphur dioxide are used to determine the IQUA. The IQUA is available hourly, seven days a week, at Edmonton and Calgary. The index telephone number is 427-7273 in Edmonton and 250-2099 in Calgary. In addition, the IQUA is reported by MacLaren Plansearch on The Weather Network.

The air quality index was in the Good category over 86% of the time at all Alberta Environmental Protection monitoring stations in 1993. Good air quality occurred most frequently at the Calgary residential station (98% of the time) and least frequently at the Edmonton northwest station (86%). The highest frequency of Poor air quality ratings was at the Edmonton northwest station (1.1% of the time). Very Poor air quality was recorded for one hour at the Edmonton northwest and east monitoring

| IQUA rating | Frequency in Alberta | Effects |
|---|---|---|
| Good | almost all the time | Desirable range: no known harmful effects to soil, water, vegetation, animals, materials, visibility or human health. The long-term goal for air quality in Canada is to be in this range all the time. |
| Fair | occasional (typical when weather conditions inhibit pollutant dispersion) | Acceptable range: adequate protection against harmful effects to soil, water, vegetation, animals, materials, visibility and human health. |
| Poor | very seldom | Tolerable range: not all aspects of the environment are adequately protected from possible adverse effects. Long-term control action may be necessary, depending on the frequency, duration and circumstances of the readings. |
| Very Poor | very rare | Intolerable range: at this range, further deterioration of air quality and continued high readings could pose a risk to public health. |

stations. The Very Poor reading at the Edmonton northwest station was caused by the combination of a strong temperature inversion, light winds and automobile exhaust emissions which persisted during the early morning hours on October 21. Very Poor air quality occurred at the Edmonton east station at 3:00 AM on January 10. This occurrence was likely due to a temporary emission from a local industrial facility. No other Very Poor air quality episodes were reported at Alberta Environmental Protection monitoring stations in 1993.

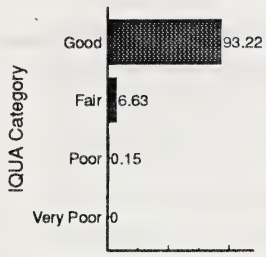
The pollutants responsible for the IQUA ratings are largely dependent on the location of the monitoring station relative to the pollutant sources. Dust and smoke (the coefficient of haze) is the most common cause of Fair, Poor and Very Poor air quality occurrences at air quality stations located near major traffic arteries or industrial sources. Ozone is the dominant pollutant at stations with less influence from vehicle traffic (i.e. Calgary residential and Fort McMurray). Carbon monoxide from vehicle exhaust occasionally is responsible for Fair air quality ratings at the Edmonton central, Calgary downtown and Calgary residential stations.

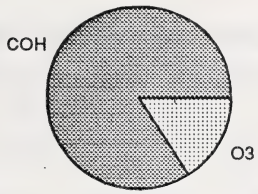
## CONTINUOUS AIR QUALITY MONITORING

Air pollutants such as ozone, carbon monoxide, carbon dioxide, the coefficient of haze, nitrogen dioxide, sulphur dioxide, hydrogen sulphide and total hydrocarbons were monitored continuously in 1993. Hourly average concentrations of these pollutants are recorded hourly, 365 days a year.

# INDEX OF THE QUALITY OF THE AIR IN 1993

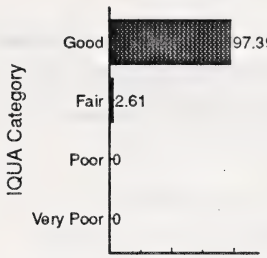
## Edmonton Central

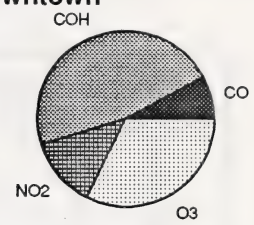



Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

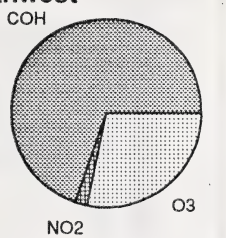
## Calgary Downtown



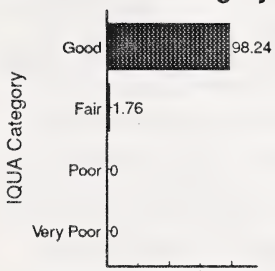

Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

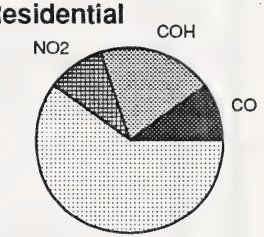
## Edmonton Northwest


Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

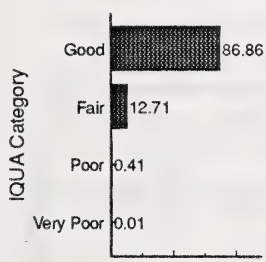
## Calgary Residential

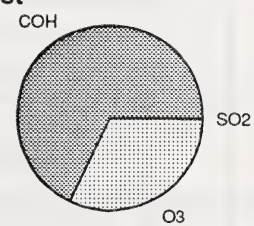



Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

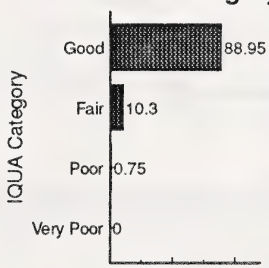
## Edmonton East

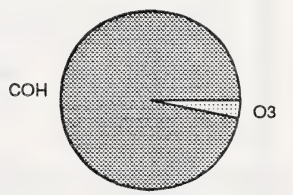



Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

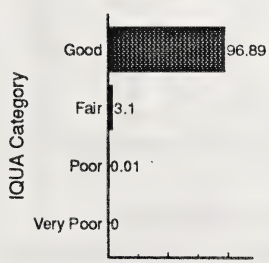
## Calgary Industrial

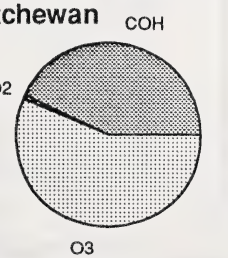



Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

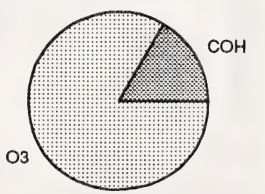
## Fort Saskatchewan



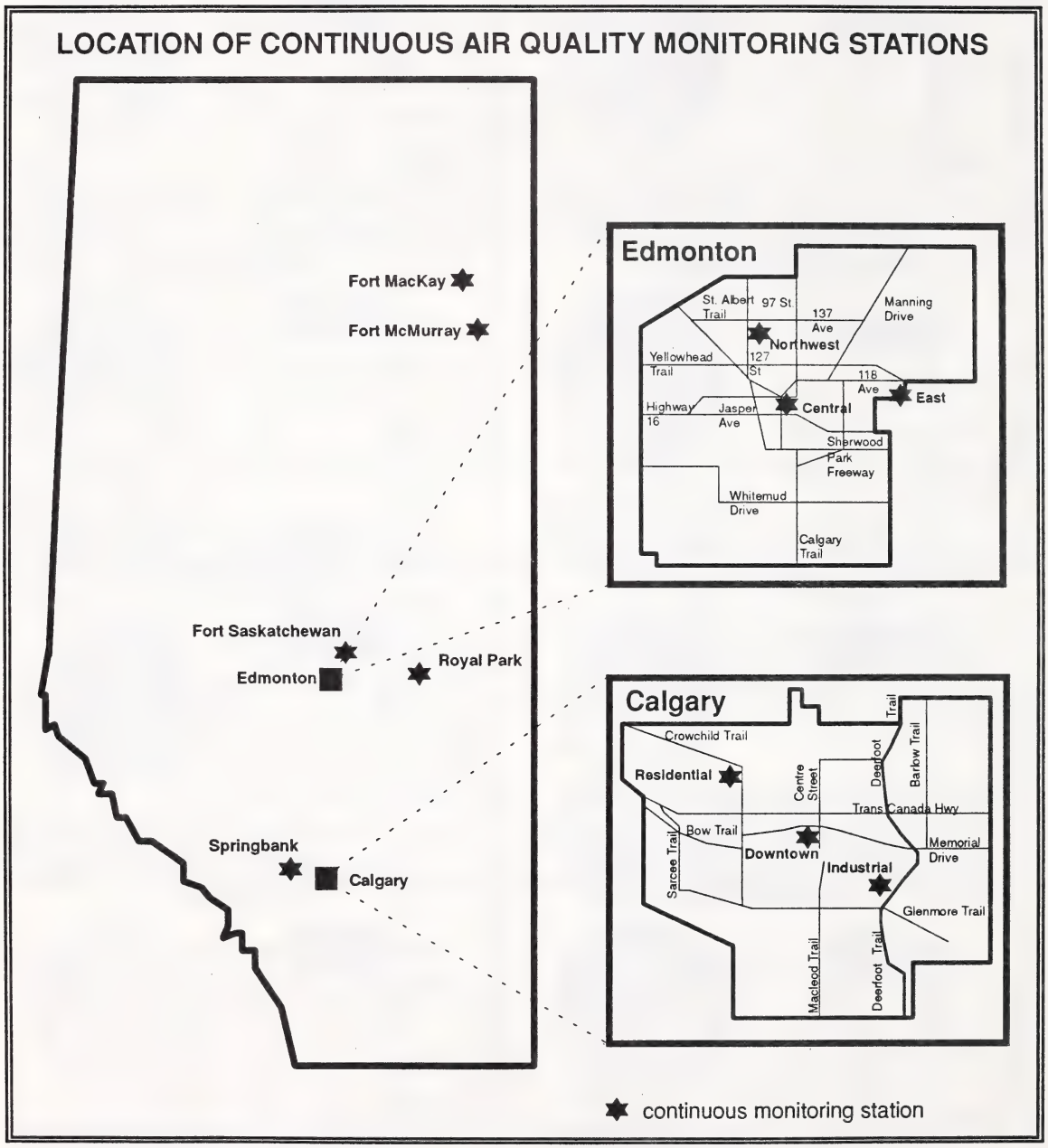

Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

## Fort McMurray


Contribution of Pollutants to the IQUA during Fair, Poor and Very Poor Air Quality

| | |
|---|---|
| Edmonton | 427-7273 |
| Calgary | 250-2099 |


LOCATION OF CONTINUOUS AIR QUALITY MONITORING STATIONS
Fort MacKay
Fort McMurray
Fort Saskatchewan
Edmonton
Royal Park
Springbank
Calgary
Edmonton
St. Albert Trail
97 St
137 Ave
Manning Drive
Northwest
Yellowhead Trail
127 St
118 Ave
East
Central
Highway 16
Jasper Ave
Sherwood Park Freeway
Whitemud Drive
Calgary Trail
Calgary
Crowchild Trail
Residential
Centre Street
Deerfoot Trail
Barlow Trail
Trans Canada Hwy
Bow Trail
Downtown
Memorial Drive
Industrial
Sarcee Trail
Glenmore Trail
Macleod Trail
Deerfoot Trail
continuous monitoring station

## Ozone ($O_3$)

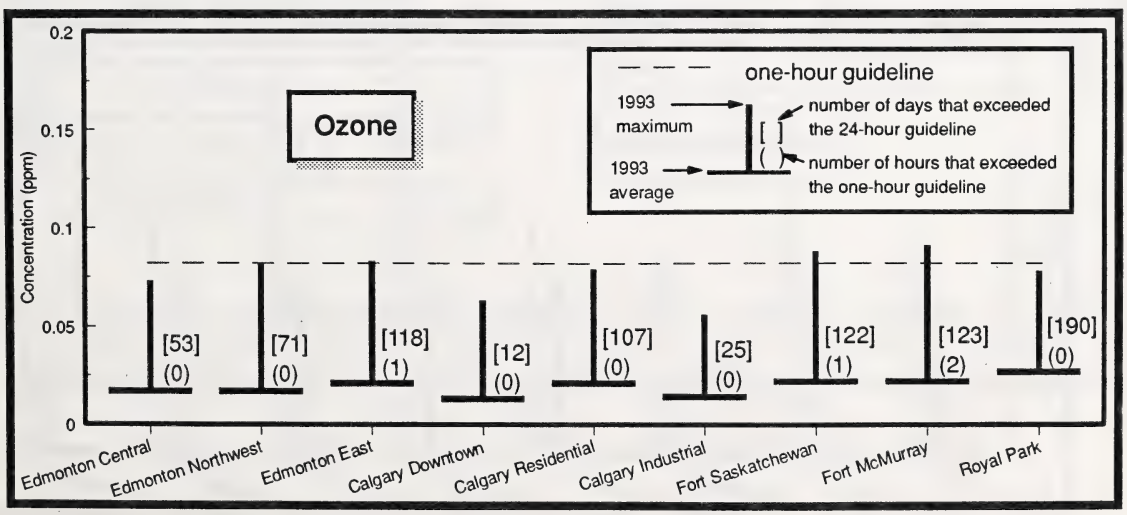
At normal outdoor concentrations, ozone is a colourless, odourless gas. However, ozone does have a characteristic sharp odour when at very high concentrations, such as that associated with lightning storms.

Unlike other pollutants, ozone is not emitted directly by man's activities, but is generated by a photochemical reaction between ultra-violet light from the sun with oxides of nitrogen ($NO_x$) and volatile organic compounds (VOCs). Ozone is also transported to ground level from the upper atmosphere by natural meteorological mixing processes. Ozone and ozone precursors, such as $NO_x$ and VOCs, may also be carried from upwind sources such as urban centres and industrial complexes. A major source of VOCs in rural areas is natural emissions from trees and vegetation. In Alberta, ozone concentrations are generally higher at rural locations than at urban locations. This is due to the destruction of ozone by nitric oxide that is emitted by automobiles.

The guidelines for ozone are as follows:

- *0.082 ppm as a 1-hour average concentration; and*
- *0.025 ppm as a 24-hour average concentration.*

Exceedances of the 1-hour guideline for ozone were recorded at the Edmonton east (1 hour), Fort Saskatchewan (1 hour) and Fort McMurray (2 hours) monitoring stations. The 24-hour guideline for ozone was exceeded at all monitoring stations. The greatest frequency of exceedances was recorded at the Fort Saskatchewan and Fort McMurray stations. The 24-hour guideline for ozone is often exceeded at pristine locations in Alberta. These exceedances are primarily due to natural ozone generating processes such as: (1) the reaction of sunlight with naturally occurring hydrocarbons and oxides of nitrogen; and (2) transport of ozone from the upper atmosphere.



Maximum ozone values were observed during the spring and summer months at all monitoring stations in Alberta. During the late spring and summer, ozone production in the lower atmosphere is at a maximum due to a peak in incoming sunlight combined with stagnant weather conditions which may cause reactive pollutants to remain in the region for a prolonged period of time. During the early spring, high daily average ozone values may be influenced by transport of ozone from the upper atmosphere.

## *Carbon Monoxide (CO)*

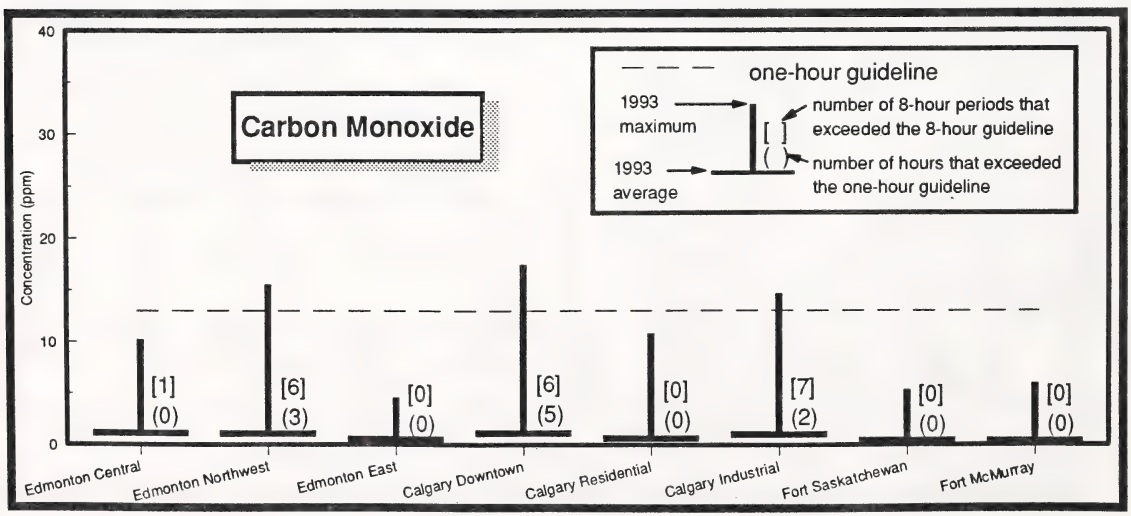
Carbon monoxide is a colourless, odourless gas emitted into the atmosphere primarily by motor vehicles. Minor sources include fireplaces, industry, aircraft and natural gas combustion.

In regulating carbon monoxide, Alberta has adopted Environment Canada's most rigorous ambient air quality objectives. Maximum permissible carbon monoxide concentrations are:

- *13.0 ppm as a 1-hour average concentration; and*
- *5.0 ppm as an 8-hour average concentration.*

The 1-hour guideline for carbon monoxide was exceeded at the Edmonton northwest (3 hours), Calgary downtown (5 hours) and Calgary industrial (2 hours) monitoring stations in 1993. The 8-hour guideline was exceeded at the Edmonton central (1 time) and northwest (6 times) monitoring stations, and the Calgary downtown (6 times) and industrial (7 times) monitoring stations. The majority of exceedances of the guidelines occurred during the fall and winter. The major factor which caused exceedances of the guidelines for carbon monoxide was vehicle exhaust emissions during stagnant weather conditions.

Concentrations of carbon monoxide were generally at a maximum during the morning and afternoon rush hours. This pattern is especially apparent at the downtown monitoring locations in Edmonton and Calgary.

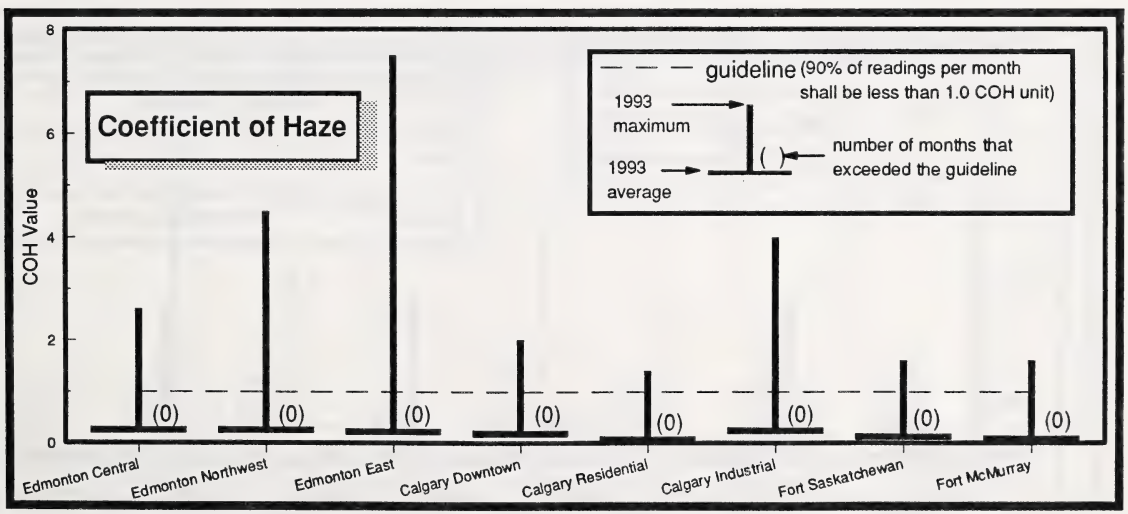


## *Coefficient of Haze (COH)*

The coefficient of haze is a measurement of the degree of dust and smoke in the atmosphere. Dust and smoke may originate from road dust, wind-blown soil, industrial sources, vehicle emissions, agricultural activities, open burning and various other sources. The guideline for the coefficient of haze, which is based on visibility, established by Alberta Environmental Protection is that:

- *90% of the readings per month shall be less than 1.0 COH unit.*

The guideline for the coefficient of haze was not exceeded at any monitoring stations in 1993. Coefficient of haze values were much higher at urban stations in Edmonton and Calgary than at the more rural Fort Saskatchewan and Fort McMurray monitoring stations. Coefficient of haze values were typically greatest during the fall and winter when meteorological conditions inhibit pollutant dispersion. High COH values lead to the occurrence of Very Poor air quality occurrences on October 21 at the Edmonton northwest station and January 10 at the Edmonton east monitoring station. Greater dust and smoke values are apparent during the morning and afternoon rush hours. This is indicative of vehicular exhaust and traffic movement which contribute to dust and smoke in the atmosphere.



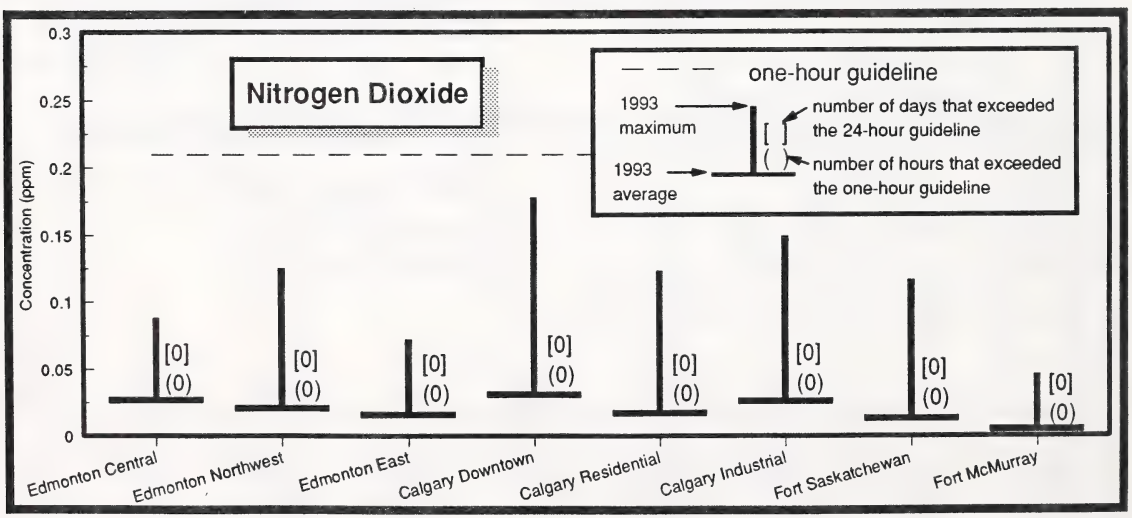
## *Nitrogen Dioxide ($NO_2$)*

In Alberta, about 38% of nitrogen dioxide emissions are produced by the oil and gas industry while 29% are due to transportation (aircraft and vehicles) and 16% due to power plants. Smaller sources of nitrogen dioxide include natural gas combustion, heating fuel combustion, and forest fires. The largest urban source of nitrogen dioxide is emissions from motor vehicles. Guidelines for nitrogen dioxide are based on human health effects. The guidelines are:

- *0.21 ppm as a 1-hour average concentration;*
- *0.11 ppm as a 24-hour average concentration; and*
- *0.03 ppm as an annual average concentration.*

The 1-hour and 24-hour guidelines for nitrogen dioxide were not exceeded at any Alberta Environmental Protection stations in 1993. However, as in previous years, the annual average guideline of 0.030 ppm was exceeded at the Calgary downtown station (0.031 ppm). The highest nitrogen dioxide concentrations were generally observed at the Calgary downtown, Edmonton central and Calgary industrial stations. Sources of nitrogen dioxide in these areas are vehicle exhaust emissions and heating fuel consumption.

Maximum nitrogen dioxide concentrations are observed in the winter. This is likely due to vehicular exhaust emissions combined with persistent stable weather conditions. As with carbon monoxide and the coefficient of haze, nitrogen dioxide peaks are evident during the morning and afternoon traffic rush hours.



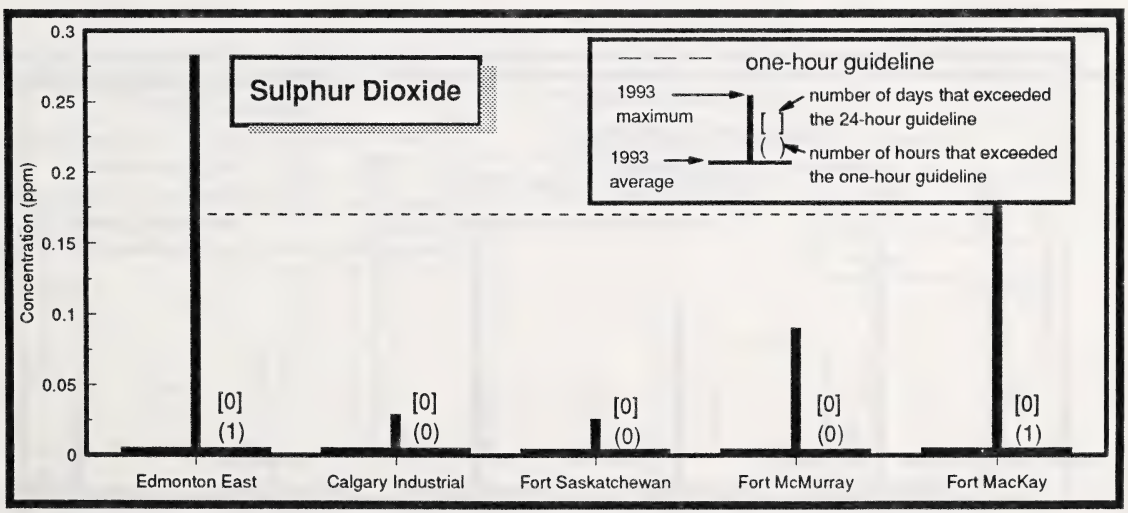
## Sulphur Dioxide ($SO_2$)

Sulphur dioxide is a colourless gas with a pungent odour. In Alberta, it is estimated that 38% of sulphur dioxide emissions are emitted by sulphur extraction plants while oil sands and power plants produce about 29% and 16%, respectively. Other sources include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

Alberta Environmental Protection has adopted Environment Canada's most rigorous objectives for sulphur dioxide. The following guidelines are based on prevention of effects to vegetation:

- *0.17 ppm as a 1-hour average concentration;*
- *0.06 ppm as a 24-hour average concentration; and*
- *0.01 ppm as an annual average concentration.*

One exceedance of the 1-hour guideline for sulphur dioxide was recorded at the Edmonton east and Fort MacKay monitoring stations in 1993. The exceedance at the Edmonton east location was due to an emission from a local industry. Elevated sulphur dioxide readings at Fort MacKay location were due to emissions from the oil sands processing plants located south of the Fort MacKay. The guidelines for sulphur dioxide were not exceeded at any other monitoring stations.



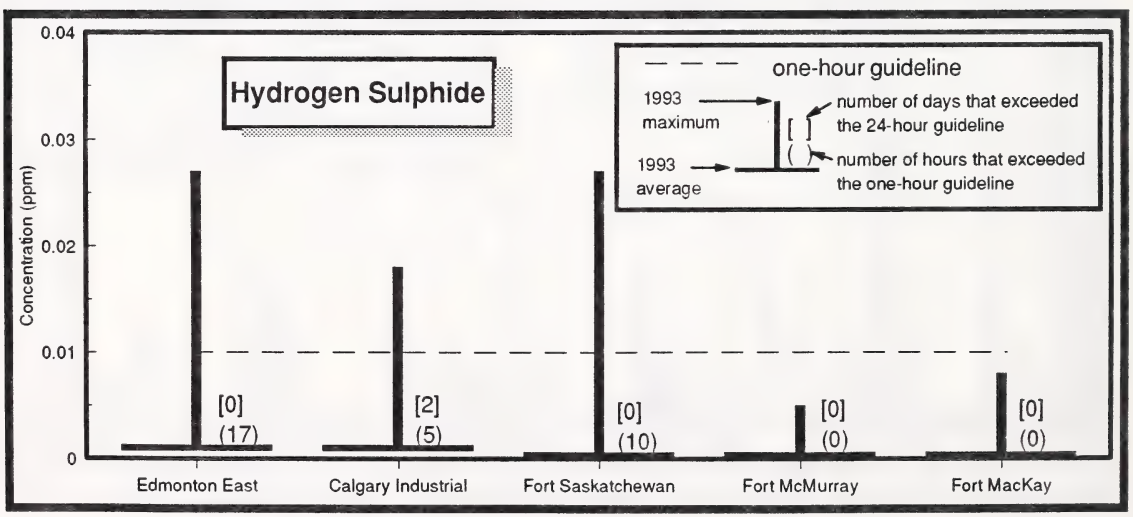
## Hydrogen Sulphide ($H_2S$)

Hydrogen sulphide is a colourless gas with a rotten egg odour. Industrial sources include petroleum refineries, natural gas plants, petrochemical plants, coke oven plants, and pulp and paper plants which use the kraft pulping process. Natural sources of hydrogen sulphide include sulphur hot springs, sloughs, swamps and lakes.

Guidelines for hydrogen sulphide are based on the odour threshold; however, many individuals can smell hydrogen sulphide at levels lower than the ambient guideline. The guidelines for hydrogen sulphide in Alberta are:

- *0.010 ppm as a 1-hour average concentration; and*
- *0.003 ppm as a 24-hour average concentration.*

The 1-hour guideline for hydrogen sulphide was exceeded at the Edmonton east (17 hours), Calgary industrial (4 hours) and Fort Saskatchewan (10 hours) monitoring stations. The 24-hour guideline was exceeded two times at the Calgary industrial station. Exceedances of these guidelines were likely caused by fugitive emissions from industrial sources or sewage treatment facilities in the vicinity the stations.

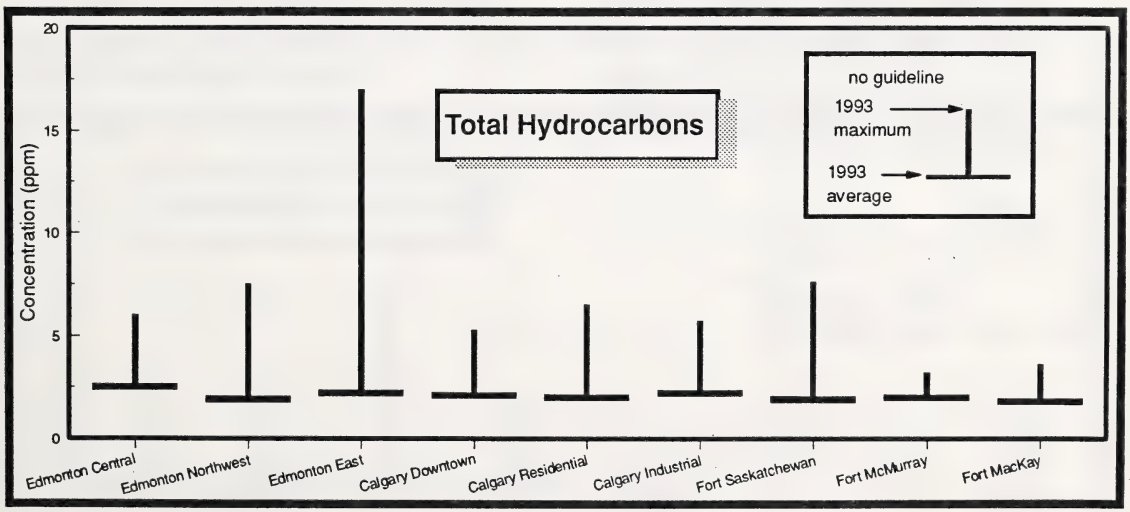


## *Total Hydrocarbons (THC)*

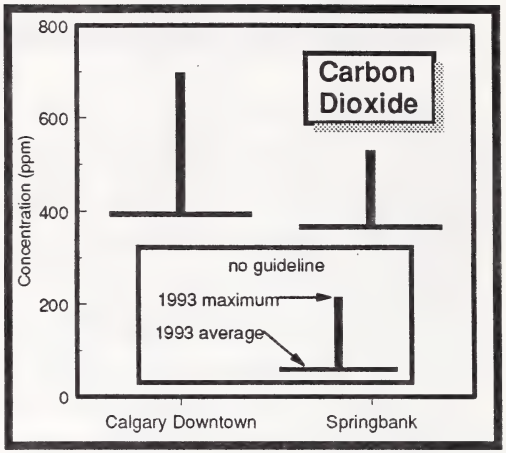
The term "total hydrocarbons" refers to methane and reactive hydrocarbons. Reactive hydrocarbons (or volatile organic compounds) may react with sunlight to form ozone. Sources of hydrocarbons include vegetation, vehicular emissions, gasoline marketing and storage tanks, petroleum and chemical industries, drycleaning, fireplaces, natural gas combustion and aircraft traffic. Alberta does not have guidelines for ambient (outdoor) concentrations of total hydrocarbons.

The highest annual average total hydrocarbon value occurred at the Edmonton central monitoring location in 1993. Occasional occurrences of 1-hour average values greater than 10 ppm were recorded at the Edmonton east monitoring station. The maximum 1-hour average total hydrocarbon concentration recorded at the Edmonton east location was 17 ppm. Elevated hydrocarbon concentrations in east Edmonton were due to fugitive emissions from industrial sources and vehicular emissions. Vehicular emissions are the major source of hydrocarbons in downtown Edmonton. Normal background total hydrocarbon concentrations are about 1.5 ppm.

Hydrocarbon concentrations were highest in the winter months at monitoring stations which are located close to major traffic arteries. In downtown Edmonton and Calgary, maximum hydrocarbon values were observed during the morning and afternoon rush hours. This shows that vehicles are the major source of hydrocarbons at urban locations.



## *Carbon Dioxide ($CO_2$)*




Carbon dioxide is a colourless, odourless, non-toxic gas that is produced by man through the combustion of fossil fuels. Major natural sources of carbon dioxide include the respiration processes of micro-organisms and plants. Carbon dioxide emissions comprise over half of the greenhouse gases emitted by man. At the present time, guidelines do not exist for ambient levels of carbon dioxide.

Alberta Environmental Protection monitors carbon dioxide in downtown Calgary and Springbank (20 km west-northwest of downtown Calgary). In 1993, average concentrations of carbon dioxide at the Calgary downtown and Springbank stations were 394 and 366 ppm, respectively. These values are higher than annual average concentrations recorded at Crossfield (40 km north of Calgary) from November, 1985 to October, 1987 which ranged from 345 to 348 ppm. Average background carbon dioxide values are about 345 ppm at pristine locations. Higher carbon dioxide concentrations in downtown Calgary are primarily due to vehicle exhaust emissions.

## INTERMITTENT AIR QUALITY MONITORING

Intermittent air quality monitoring refers to air pollutants which are monitored as a 24-hour accumulated loading, once every sixth day, in accordance with the National Air Pollution Surveillance (NAPS) monitoring schedule. In 1993, suspended particulates, benzo (a) pyrene, sulphates and nitrates were monitored according to this schedule.

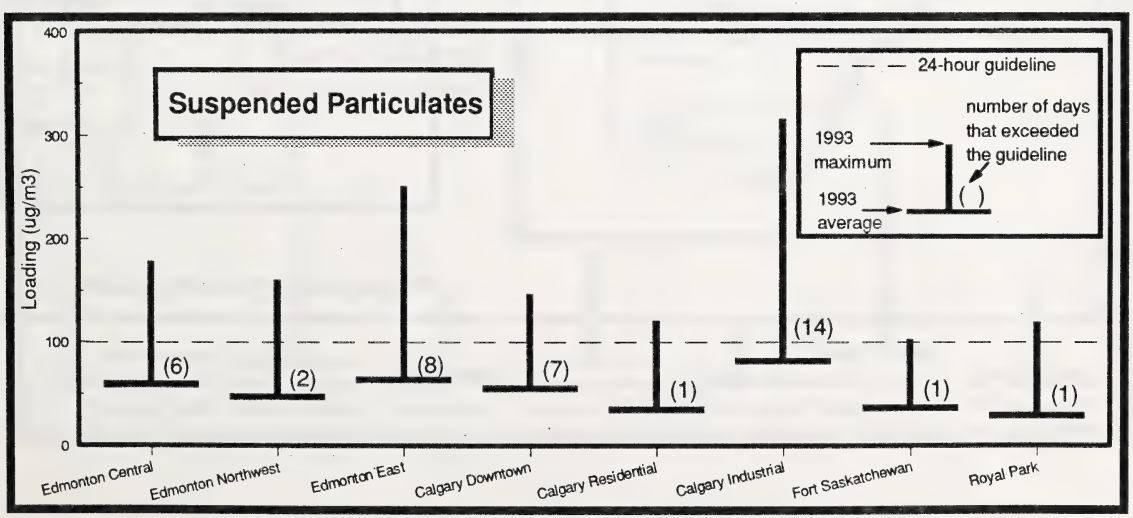
### Total Suspended Particulates (TSP)

Suspended particulates are particles which range from about 0.001 to 500 microns in diameter (a human hair is about 100 microns in diameter) and, depending on their density, may remain suspended in the air for an indefinite period of time. Suspended particulates may originate from soil, road and agricultural dust; smoke from forest fires and recreational fires; vehicular exhaust emissions; and industrial sources.

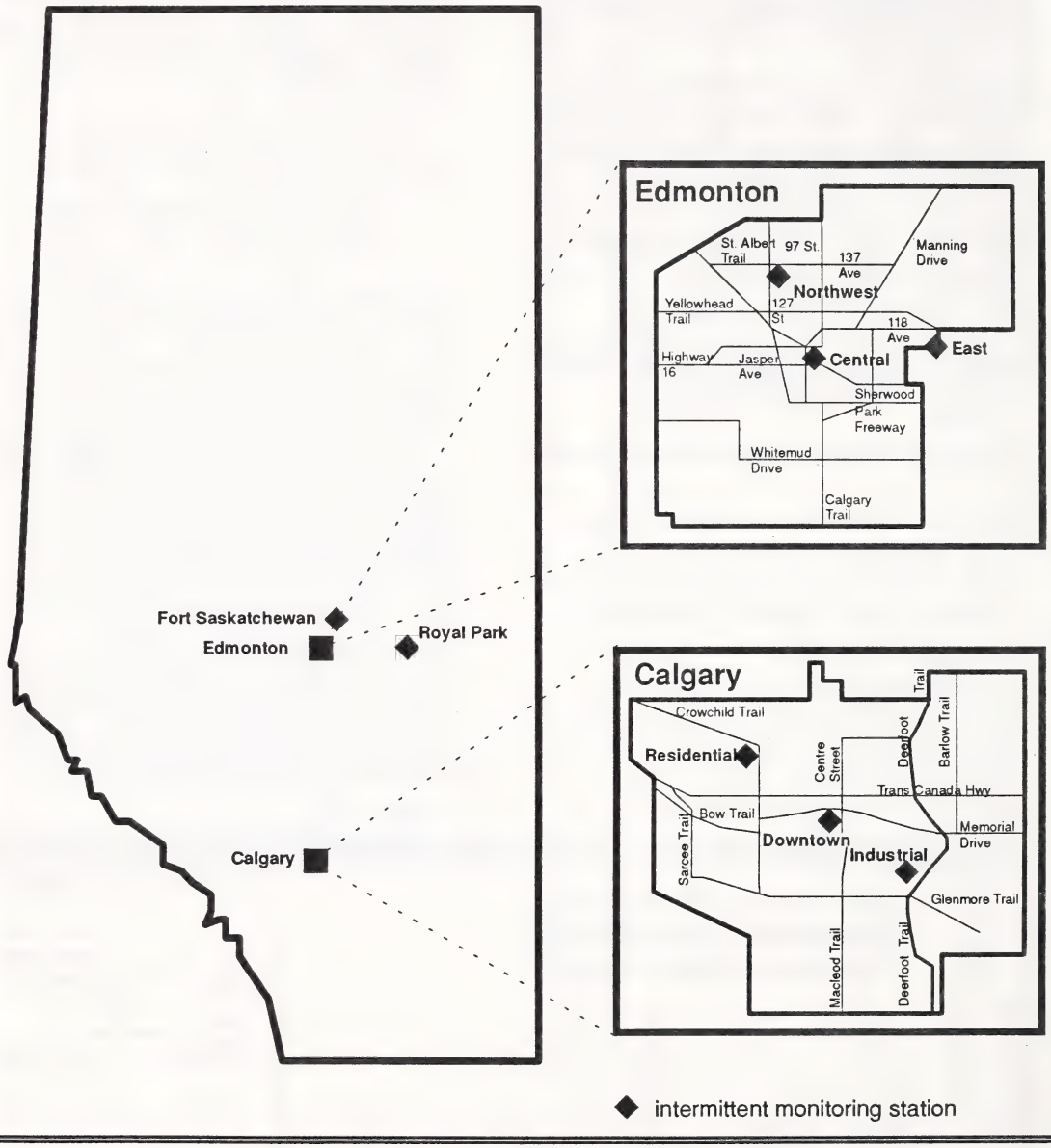
The guidelines for total suspended particulates are based on nuisance effects and visibility reduction. Alberta Environmental Protection has adopted the following federal standards for total suspended particulate loadings:

- *100 ug/m$^3$ as a 24-hour total loading; and*
- *60 ug/m$^3$ as an annual average loading.*

The 24-hour guideline for total suspended particulates was exceeded occasionally at all suspended particulate stations in 1993. The highest number of exceedances was at the Calgary industrial station where the guideline was exceeded 14 times. The annual average guideline for TSP was exceeded at the Edmonton east and Calgary industrial monitoring stations. Annual average loadings were 63.7 and 81.4 ug/m$^3$ at these two stations, respectively. Sources of suspended particulates at the Calgary industrial and Edmonton east stations were vehicle traffic and industrial emissions. The major source of suspended particulates in downtown Edmonton and Calgary was vehicle traffic.



## LOCATION OF INTERMITTENT AIR QUALITY MONITORING STATIONS



## Benzo (a) Pyrene (BaP)

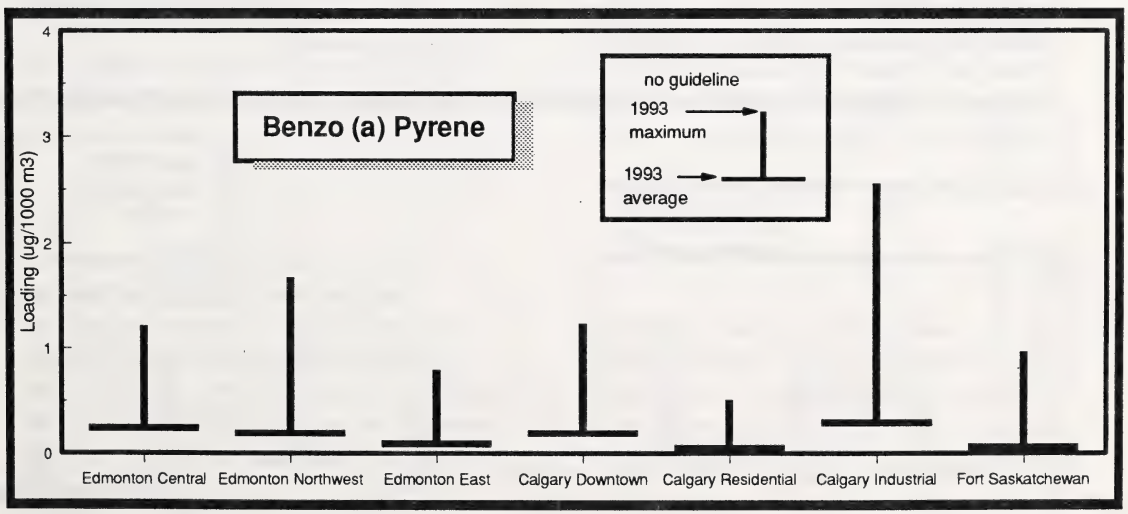
Benzo (a) pyrene is a polycyclic aromatic hydrocarbon (PAH) that is contained in all types of soot and smoke. Vehicular exhaust, and smoke from industrial and recreational emissions are the most common sources of benzo (a) pyrene. No air quality guidelines currently exist in Alberta for benzo (a) pyrene.

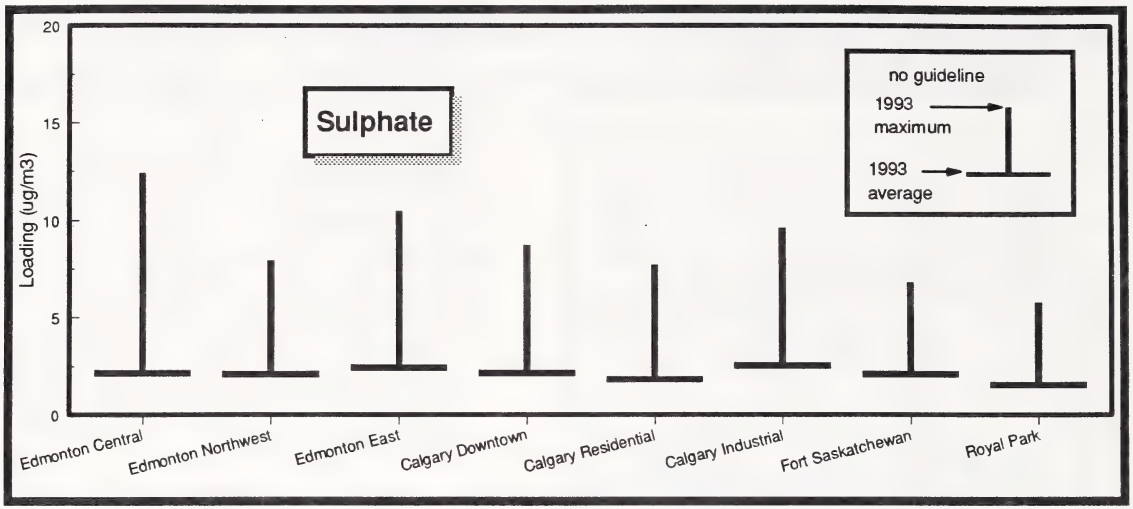
Benzo (a) pyrene loadings were significantly higher at monitoring stations located close to major traffic arteries (i.e. Edmonton central, Edmonton northwest, Calgary downtown and Calgary industrial). The major source of Benzo (a) Pyrene at these locations is vehicular emissions.

## Sulphates

The primary sources of sulphur compounds include natural gas processing facilities, oil sands facilities, power plants, oil refineries, pulp and paper mills, fertilizer plants, sulphur hot springs, sloughs and swamps. Dust from sulphur containing rocks and soil is a common natural source of particulate sulphate. Sulphate also originate as an oxidized form of sulphur dioxide and other sulphur compounds.

On average, the highest sulphate concentrations were reported at the Edmonton east and Calgary industrial monitoring stations. However, the overall peak sulphate concentration was observed at the Edmonton downtown station. Annual average sulphate concentrations measured in 1993 were higher than those recorded from 1985 to 1987 at Alberta stations.

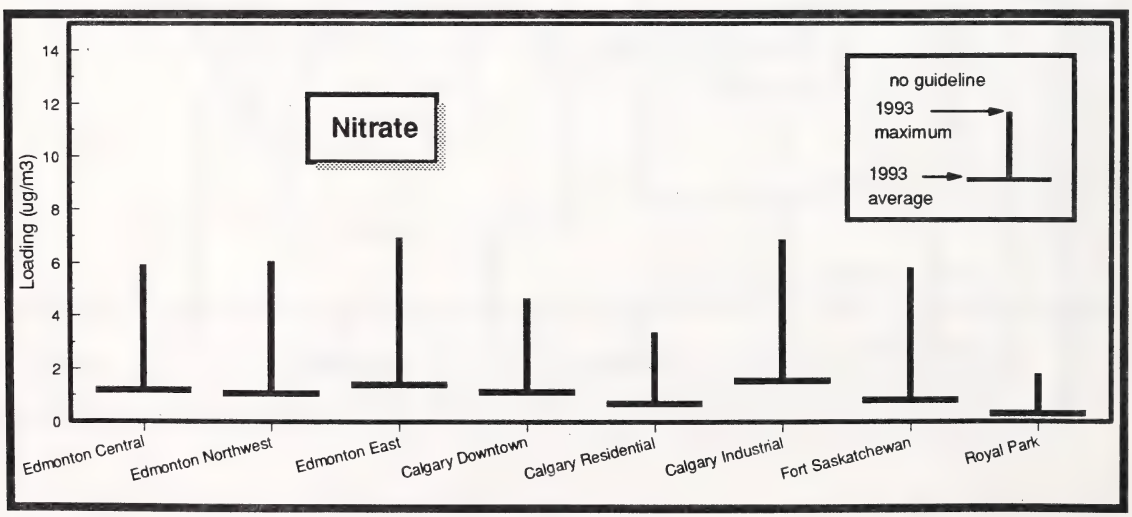





## *Nitrates*

The major sources of oxides of nitrogen in Alberta are natural gas processing facilities, transportation, power plants, natural gas and heating fuel use, agricultural fuel use, forest fires, fertilizer plants and nitric acid plants. Wind-blown dust and soil will also contain particulate nitrate. Nitrates can also emanate from oxidized forms of oxides of nitrogen (including nitrogen dioxide, nitrous oxide and nitric oxide).

The highest annual average nitrate concentrations were recorded at the Calgary industrial and Edmonton east monitoring stations. Relatively high nitrate concentrations were also recorded in downtown Edmonton and Calgary. As with sulphates, nitrate concentrations were higher in 1993 than those at other Alberta stations from 1985 to 1987.



## STATIC AIR QUALITY MONITORING

Alberta Environmental Protection conducts air quality monitoring, on a static basis, at 51 networks throughout Alberta. Each network consists of at least one monitoring station. Static monitoring is the measurement of total accumulated loadings of pollutants on a one- and three-month schedule. This type of air quality monitoring is useful as a simple, inexpensive indicator of trends. Parameters monitored on a static basis include total sulphation, hydrogen sulphide, dustfall, calcium and fluorides.

### Total Sulphation

Total sulphation is the measurement of sulphur-containing compounds which exist in the atmosphere. Sulphur recovery gas plants, coal-burning power plants and petroleum refining plants are common sources of these gases.

The guideline for total sulphation loading in Alberta is:

- *0.50 mg $SO_3$ equivalent/day/ 100 sq cm.*

Exceedances of the guideline for total sulphation did not occur at any static monitoring networks in 1993. The highest annual average total sulphation loadings were observed at the Coleman and Redwater networks. Industrial activities are the most likely sources of relatively high values at these locations.

### Hydrogen Sulphide

Hydrogen sulphide is present in the atmosphere from natural sources such as coal, natural gas, oil, sulphur hot springs, sloughs, swamps and lakes. Industrial sources of hydrogen sulphide include petroleum refining plants, natural gas plants, petrochemical complexes, coke oven plants, pulp and paper plants employing the kraft pulping process, and petroleum and gas gathering fields.

The guideline for hydrogen sulphide loading in Alberta is:

- *0.10 mg $SO_3$ equivalent/day/ 100 sq cm.*

The guideline for static hydrogen sulphide was not exceeded at any Alberta Environmental Protection monitoring stations in 1993. The highest annual average hydrogen sulphide value was recorded at the Fort McMurray network. Relatively high annual average hydrogen sulphide loadings were also recorded at the St. Albert and Camrose monitoring networks. Relatively high loadings at these locations were likely caused by industrial activity in the region.

### Total Dustfall

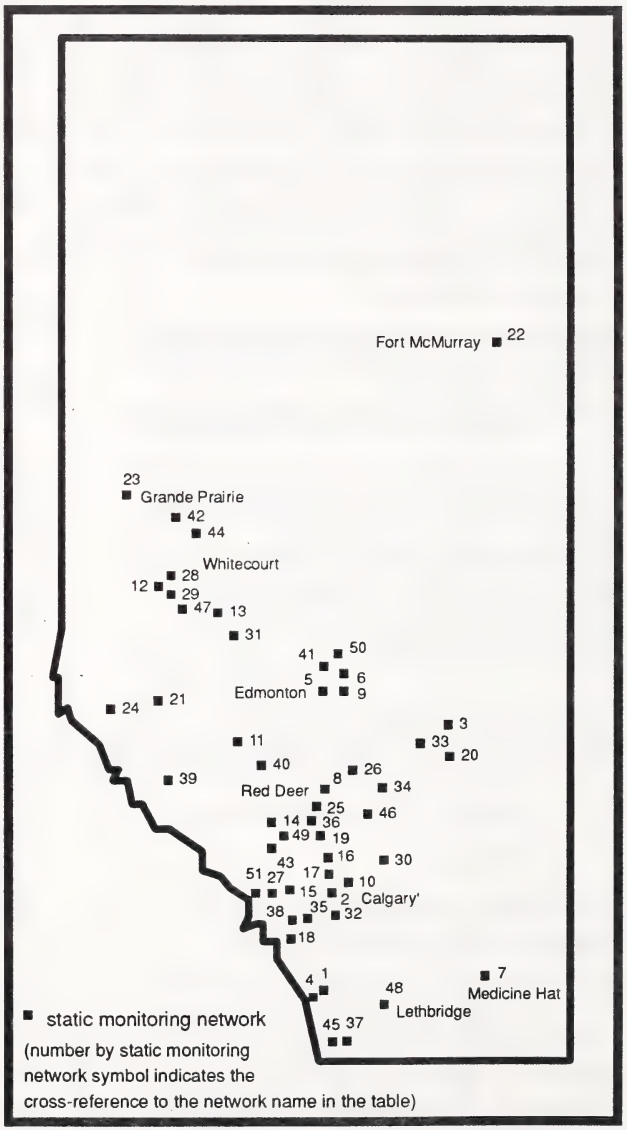
Dustfall is particulate matter which is too heavy to remain suspended in the atmosphere indefinitely. Sources of dustfall include wind-blown soil, road dust, dust generated by agricultural activities, ash from forest fires

# LOCATION OF STATIC AIR QUALITY MONITORING NETWORKS

| Map Location | Network Location |
|---|---|
| 1 | Blairmore |
| 2 | Calgary |
| 3 | Camrose |
| 4 | Coleman |
| 5 | Edmonton |
| 6 | Fort Saskatchewan |
| 7 | Medicine Hat |
| 8 | Red Deer |
| 9 | Sherwood Park |
| 10 | Balzac |
| 11 | Buck Lake |
| 12 | Bigstone |
| 13 | Blue Ridge |
| 14 | Caroline |
| 15 | Cochrane |
| 16 | Carstairs |
| 17 | Crossfield |
| 18 | Diamond Valley |
| 19 | Didsbury |
| 20 | Edburg |
| 21 | Edson |
| 22 | Fort McMurray |
| 23 | Grande Prairie |
| 24 | Hinton |
| 25 | Innisfail |
| 26 | Joffre |
| 27 | Jumping Pound |
| 28 | Kaybob |
| 29 | Kaybob (south) |
| 30 | Lone Pine Creek |
| 31 | Mayerthorpe |
| 32 | Mazeppa |
| 33 | New Norway |
| 34 | Nevis |
| 35 | Okotoks |
| 36 | Olds |
| 37 | Pincher Creek |
| 38 | Quirk Creek |
| 39 | Ram River |
| 40 | Rimbey |
| 41 | St. Albert |
| 42 | Simonette |
| 43 | Sundre |
| 44 | Valleyview |
| 45 | Waterton |

| Map Location | Network Location |
|---|---|
| 46 | Wimborne |
| 47 | Windfall |
| 48 | Lethbridge |

| Map Location | Network Location |
|---|---|
| 49 | Raven Brood |
| 50 | Redwater |
| 51 | Exshaw |



and recreational fires, and flyash from industrial sources.

The Alberta Environmental Protection guidelines for total dustfall loadings are:

- *53 mg/100 sq cm/30 days in residential and recreational areas;*
- *158 mg/100 sq cm/30 days in commercial and industrial areas.*

Total dustfall loadings exceeded Alberta Environmental Protection guidelines for residential regions at all networks with the exception of Camrose. Guidelines for industrial regions were exceeded at 6 of these networks. The highest frequency of exceedances of the residential guideline for dustfall was at the Lethbridge network where the guideline was exceeded 50% of the time. The Calgary network recorded the highest number of frequencies of the industrial guideline (19%). The major sources of dustfall in Alberta include road dust, agricultural dust, dust from industrial sources, and vehicular exhaust.

## Calcium

Calcium emanates from natural sources such as wind-blown soil and road dust. Man-made sources of calcium in dustfall include cement, iron, steel and wood processing. There are no guidelines or guidelines for atmospheric loadings of calcium in Alberta.

As in previous years, the highest annual average calcium loading was recorded at the Exshaw network where a loading of 12.9 milligrams per 100 square centimeters per 30 days was reported. This value is almost 75% higher than the calcium loadings recorded in the Edmonton area. Relatively high calcium loadings in the Exshaw region may be attributed to cement manufacturing and limestone mining activities in the area.

## Fluorides

Fluorides are emitted into the atmosphere through processes such as coal combustion and the processing of phosphate bearing rock.

The Alberta Environmental Protection guideline for fluoride loading is:

- *40.0 ug water soluble fluorides/100 sq cm/30 days*

Fluorides are monitored near Redwater and Fort Saskatchewan by Alberta Environmental Protection. In 1993, the guideline for fluorides was exceeded 21% of the time at the Redwater monitoring network. The guideline was not exceeded at the Fort Saskatchewan monitoring network. High loadings in the Redwater area are likely due to fertilizer and phosphoric acid manufacturing operations.

## PRECIPITATION QUALITY MONITORING

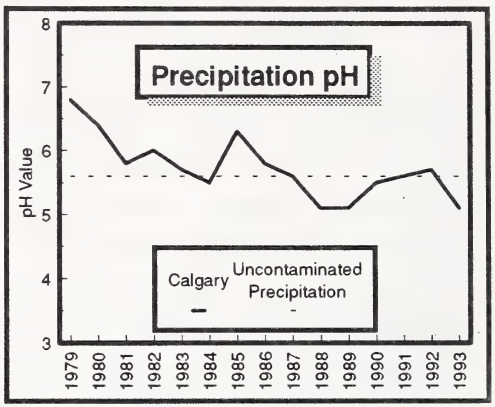
Rain and snow samples were collected, on a weekly basis, at 12 locations in the province by Alberta Environmental Protection in 1993. Chemical analysis was conducted on these samples to obtain pH as well as other ions contained in precipitation. The effective acidity of the precipitation was also calculated. Target loadings for acid precipitation are currently being developed by Alberta Environmental Protection.

### pH

The most acidic (lowest pH) precipitation was recorded at the Fort McMurray precipitation monitoring station where an annual average pH value of 4.7 was observed. Precipitation pH was 5.0 or above at all other provincial monitoring stations. The highest annual average pH values were recorded at Vegreville, High Prairie and Cold Lake (pH of 5.3). Uncontaminated precipitation has a pH value close to 5.6.

Based on an analysis of precipitation samples collected from 1978 to 1990, average pH values ranged from 5.0 at Fort Chipewyan to 6.1 at High Prairie. Beaverlodge, Cold Lake, Fort McMurray, and Kananaskis recorded average pH values of 5.2 or less for this period. The average pH of precipitation on a province wide basis was 5.5, close to that of uncontaminated precipitation.

A significant decrease in pH values is evident at several monitoring sites. This decrease is most apparent at the Calgary precipitation station. Lower pH values (or increased acidity) may be caused by: improved sampling techniques (i.e. less wind blown dust in the sample); or a change in the location of the monitoring site.




### Anions (sulphate, nitrate, chloride, phosphate)

Anions in precipitation may result from emissions into the atmosphere from coal-fired power plants, oil refineries, gas plants, oil sands plants, pulp and paper plants, fertilizer plants, vehicular emissions and agricultural activities. Alberta Environmental Protection does not have guidelines for anions in precipitation.

In 1993, the highest sulphate and nitrate deposition rates were recorded at the Vegreville and Kananaskis precipitation quality stations. Chloride and phosphate concentrations were relatively low at all monitoring stations. Maximum chloride and phosphate values were observed at the Cold Lake station.

## LOCATION OF PRECIPITATION QUALITY MONITORING STATIONS


precipitation quality monitoring station

### *Cations (calcium, ammonium, sodium, magnesium, potassium)*

Cations may originate from industrial sources such as iron and steel manufacturing, wood processing, or natural sources such as wind-blown soil and dust. There are currently no guidelines for cations in precipitation in Alberta.

Calcium concentrations in precipitation were highest at the High Prairie monitoring station in 1993. Wet ammonium was highest at the Vegreville monitoring station. Concentrations of sodium, magnesium and potassium were low at all locations. The highest values of sodium and potassium were recorded at Suffield and High Prairie stations, respectively. Maximum magnesium concentrations were recorded at Fort McMurray and Kananaskis precipitation quality stations.

### *Effective Acidity*

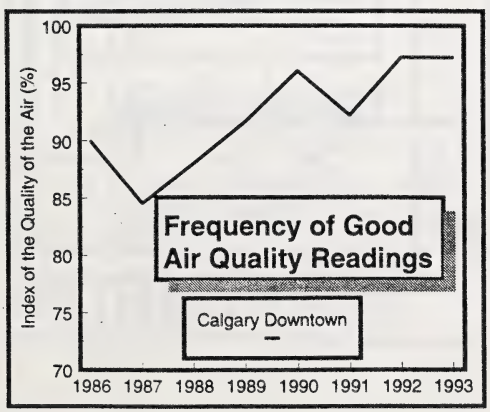
Effective acidity is an approach which has been developed to estimate the amount of acidity produced in the soil due to physical, chemical and biological processes which occur as a result of acid deposition. The highest calculated annual effective acidity rates occurred at Vegreville, Cold Lake and Kananaskis monitoring stations. Annual values recorded at these locations were slightly higher than the lower limit of the effective acidity range proposed for sensitive soils. The proposed range for effective acidity limits is 0.1 to 0.3 kg/ha/yr of $H^+$ (hydrogen ion equivalent) for sensitive soils.

## AIR QUALITY TRENDS

The long-term trend of air pollution levels is an important indicator of changes in air quality. Approximately 18 years of data are available for ozone, carbon monoxide, the coefficient of haze, nitrogen dioxide and total hydrocarbons. Suspended particulate, lead and benzo (a) pyrene data are available for 14, 13 and 12 years, respectively at most stations. Annual average concentrations for hydrogen sulphide and sulphur dioxide are not high enough to resolve significant trends. Not enough data is available for carbon dioxide to determine annual average trends. Index of the Quality of the Air trends are based on 8 years of data.

### *Index of the Quality of the Air*

A trend towards more frequent Good air quality ratings is visible at the Calgary downtown station based on eight years of data (1986 to 1993). In 1993, Good air quality was more frequent than the long-term average at all Calgary stations, as well as Fort Saskatchewan and Fort McMurray stations. Good air quality was less frequent than the eight year average at the Edmonton downtown and east stations. The frequency of Good air quality at the Edmonton northwest station in 1993 was very close to the eight year average.

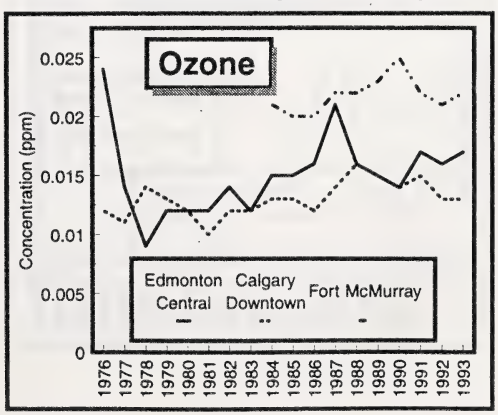



### *Ozone*

Ozone is formed in the lower atmosphere through the reaction of sunlight with oxides of nitrogen and volatile organic compounds (VOCs). The transport of ozone from the upper atmosphere to ground level is also an important contributor to ozone levels in the lower atmosphere. At urban locations in Alberta, ozone is often destroyed by nitric oxide emitted by automobiles.

An upward trend in annual average ozone concentrations is evident from data collected at the Edmonton central, Calgary downtown and Fort McMurray monitoring stations. Upward trends in ozone in downtown Calgary and Edmonton may be linked to lower concentrations of oxides of nitrogen at these locations. In Fort McMurray, higher ozone values may be due to higher concentrations of ozone precursors (VOCs and oxides of nitrogen) or increased transport of ozone from the upper atmosphere to ground level.

In 1993, annual average ozone values were higher than the long-term average at the Edmonton central and Fort McMurray monitoring stations. Annual average concentrations at the Edmonton east and Calgary downtown stations were close to the long-term average. The remaining stations recorded annual average ozone values that were lower than the long-term average.



### *Carbon Monoxide*

The major source of carbon monoxide in urban areas is vehicular emissions. Other sources include industrial emissions, aircraft emissions, fireplaces and natural gas combustion.

Based on annual average concentrations, a downward trend in carbon monoxide is evident at the Edmonton central and northwest stations, all Calgary stations, and the Fort Saskatchewan station. Lower carbon monoxide concentrations at these stations can be attributed to more efficient automobile engines and emission control devices.

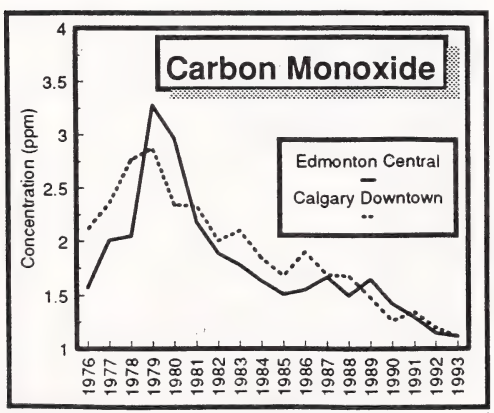
In 1993, all Alberta monitoring stations recorded an annual average carbon monoxide concentration that was substantially lower than the long-term average. A peak in annual average carbon monoxide concentrations was evident in 1979 at most monitoring stations. This peak may reflect the boom in the economy which occurred in the late 1970s (i.e. more building construction and an increase in vehicular activity).

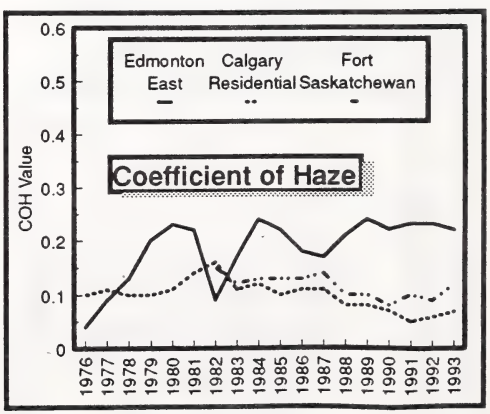
### *Coefficient of Haze*

The coefficient of haze is a measurement of dust and smoke resulting from sources such as road dust, wind-blown soil, industrial emissions, automobiles, agricultural activities, open burning and fireplaces.

A small increase in annual average coefficient of haze values is indicated at the Edmonton east location. This trend may be due to the combination of a greater traffic density in east Edmonton and increased industrial emissions in the region. A slight downward trend in coefficient of haze values is evident at the Calgary residential and Fort Saskatchewan stations. This decrease may be associated with cleaner streets in the vicinity of these stations.

All Calgary monitoring stations recorded annual average dust and smoke concentrations that were lower than the long-term average in 1993. Coefficient of haze values were higher than the long-term average at Edmonton, Fort Saskatchewan and Fort McMurray monitoring stations.



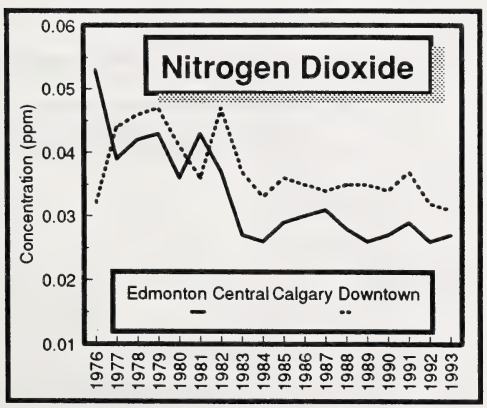



### *Nitrogen Dioxide*

Major sources of nitrogen dioxide include motor vehicle emissions, aircraft emissions, the oil and gas industry, power plants, natural gas combustion and heating fuel combustion.

Nitrogen dioxide shows a significant downward trend at the Edmonton central and Calgary downtown monitoring stations. Lower concentrations in downtown Edmonton and Calgary are likely due to decreased emissions of oxides of nitrogen from motor vehicles. This trend was most pronounced from 1981 to 1983. Nitrogen dioxide levels do not show a trend at other stations.

In 1993, annual average nitrogen dioxide concentrations were lower than the long-term average at all Alberta monitoring stations. This observation is most notable in Fort McMurray where the annual average concentration was less than half of the long-term average.

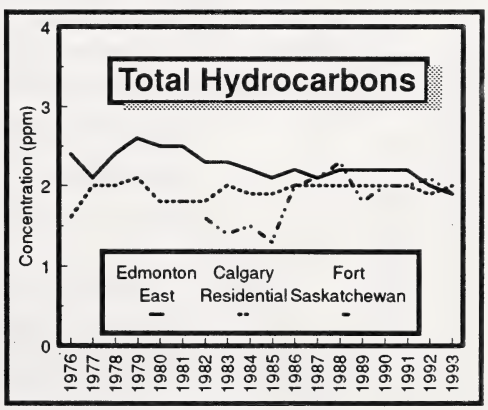



### *Total Hydrocarbons*

Hydrocarbons may be emitted from a variety of sources. Some of these sources are vehicular emissions, the petroleum and chemical industries, and vegetation.

Based on 18 years of data, a slight upward trend in hydrocarbon concentrations is noticeable at the Calgary residential and Fort Saskatchewan monitoring stations. This trend may be related to an increase of vehicular traffic in the vicinity of these stations. In addition, hydrocarbons from industrial sources likely may lead to higher hydrocarbon values at the Fort Saskatchewan station. A small downward trend in hydrocarbon values is evident at the Edmonton northwest station. Significant trends are not apparent at other monitoring stations.

In 1993, annual average total hydrocarbon concentrations were higher than the annual average at the Edmonton central, Calgary residential, Calgary industrial, Fort Saskatchewan and Fort McMurray monitoring stations. Annual average concentrations at the remaining stations were close to the same or lower than the long-term average.



### *Suspended Particulates*

Common sources of particulates in the atmosphere are road dust, wind-blown soil, automobile emissions, industrial emissions, and smoke from recreational and forest fires.

Significant decreases in suspended particulate loadings are indicated at the Edmonton central, Edmonton northwest, Calgary downtown and Calgary residential monitoring stations. The downward trend in suspended particulate loadings may be due to: (1) less road dust because of more paved roads; and (2) more efficient automobile engines.

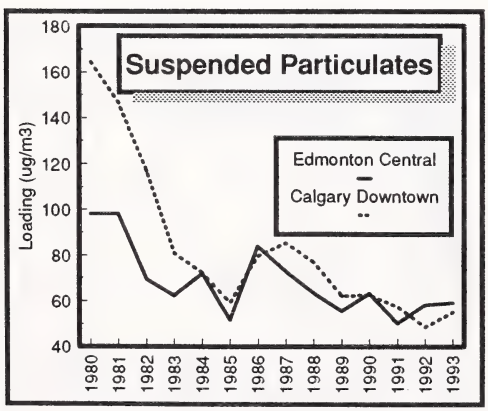
Annual average suspended particulate loadings observed in 1993 were lower than the long-term average at the Edmonton central and northwest stations, and Calgary downtown and residential stations. Suspended particulate loadings were higher than the long-term average at the remaining monitoring stations.

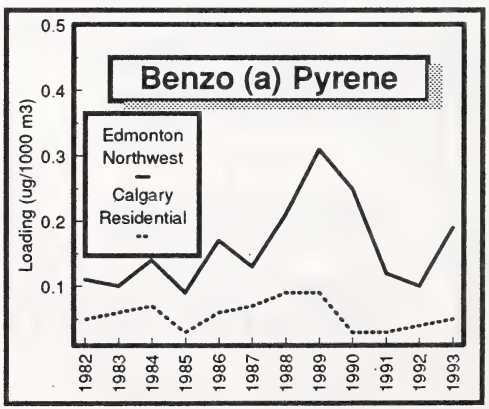
### *Benzo (a) Pyrene*

Benzo (a) pyrene is contained in all types of smoke. Major sources of benzo (a) pyrene include vehicular exhaust, smoke from industrial sources, and smoke from recreational and forest fires.

Based on data collected from 1982 to 1989, benzo (a) pyrene loadings show a significant increase at the Edmonton northwest and Calgary residential monitoring stations. However, from 1989 to 1992, benzo (a) pyrene loadings show a substantial decrease at most monitoring stations. Lower benzo (a) pyrene loadings in these years may be related to more efficient automobiles. In 1993, benzo (a) pyrene loadings show an increase over 1992 values at most stations.

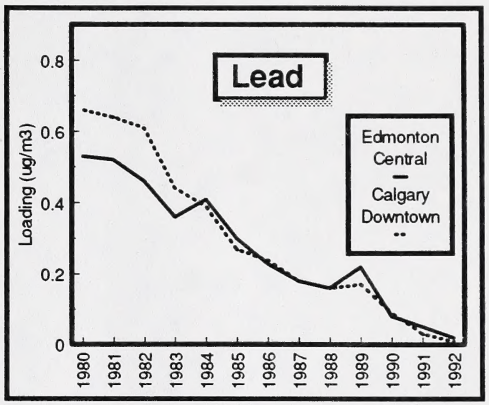
Annual average benzo (a) pyrene loadings in 1993 were higher than the long-term average at the Edmonton residential, Edmonton east, Calgary industrial and Fort Saskatchewan stations. The reason for higher loadings at these stations is not known at this time. Loadings at the remaining stations were lower than the long-term average.



### *Lead*

The major source of lead in the atmosphere is automobile emissions. Other sources of lead include the manufacturing of iron and steel.




Based on lead data collected in Alberta from 1980 to 1992, a decrease in annual average lead loadings is evident at all monitoring stations. This trend is most pronounced at the downtown locations in Edmonton and Calgary. The cause of lower lead loadings is the decrease in the use of leaded gasoline. The suspended sale of leaded gasoline at domestic gas stations is likely the reason for decreased lead loadings from 1990 to 1992.

Lead was not monitored at Alberta Environmental Protection stations in 1993. In 1992, annual average lead loadings were close to 10% of the long-term average at all air quality stations. The most significant declines are evident at the monitoring stations located close to major traffic arteries.